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(54) APPARATUS FOR PROVIDING ACCESS TO FIELD DEVICES IN A DISTRIBUTED CONTROL SYSTEM

VORRICHTUNG, DIE EINEN ZUGANG ZU FELDDGERÄTEN IN EINEM VERTEILTEN
STEUERUNGSSYSTEM GESTATTET

APPAREIL PERMETTANT D'ACCEDER A DES EQUIPEMENTS DU DOMAINE D'EXPLOITATION
A L'INTERIEUR D'UN SYSTEME DE COMMANDE DISTRIBUE

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• DATABASE INSPEC INSTITUTE OF
ELECTRICAL ENGINEERS, STEVENAGE, GB
Inspec No. 4566466, 1993 ROBERTS D.A.
"OLCHFA" a distributed time-critical fieldbus'

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Description

[0001] This invention relates to accessing field devices in a distributed control system. Specifically, this invention relates to accessing such field devices remotely using wireless transceivers, accessing functions of the field devices that may not be accessible by the controller of the distributed control system and providing redundant wireless access to such field devices remotely using wireless transceivers.

[0002] The European Patent Application EP-A-0491 657 discloses an automatic fabrication plant equipped with several fabrication stations, a storage station, interconnected transportation means and manipulation means. A central computer system controls the flow of information in two data networks, one for exchanging data with the fabrication stations and the transport stations. The second network interconnects the storage, transport and manipulation means to control transport of material to and from the fabrication stations. The two data networks have interfaces by which data can be exchanged therebetween under various protocols.

[0003] In a typical industrial plant, a distributed control system (DCS) is used to control many of the industrial processes performed at the plant. Typically, the plant has a centralized control room having a computer system with user I/O, disc I/O, and other peripherals as are known in the computing art. Coupled to the computing system is a controller and a process I/O subsystem.

[0004] The process I/O subsystem includes a plurality of I/O ports which are connected to various field devices throughout the plant. Field devices known in the control art include various types of analytical equipment, silicon pressure sensors, capacitive pressure sensors, resistive temperature detectors, thermocouples, strain gauges, limit switches, on/off switches, flow transmitters, pressure transmitters, capacitance level switches, weigh scales, transducers, valve positioners, valve controllers, actuators, solenoids, and indicator lights. As used herein, the term "field device" encompasses these devices, as well as any other device that performs a function in a distributed control system and is known in the control art.

[0005] Traditionally, analog field devices have been connected to the control room by two-wire twisted pair current loops, with each device connected to the control room by a single two-wire twisted pair. Analog field devices are capable of responding to or transmitting an electrical signal within a specified range. In a typical configuration, it is common to have a voltage differential of approximately 20-25 volts between the two wires of the pair and a current of 4-20 milliamps running through the loop. An analog field device that transmits a signal to the control room modulates the current running through the current loop, with the current proportional to the sensed process variable. On the other hand, an analog field device that performs an action under control of the control room is controlled by the magnitude of the cur-

rent through the loop, which is modulated by the I/O port of the process I/O system, which in turn is controlled by the controller. Traditional two-wire analog devices having active electronics can also receive up to 40 milliwatts of power from the loop. Analog field devices requiring more power are typically connected to the control room using four wires, with two of the wires delivering power to the device. Such devices are known in the art as four-wire devices and are not power limited, as are two-wire devices.

[0006] In contrast, traditional discrete field devices transmit or respond to a binary signal. Typically, discrete field devices operate with a 24 volt signal (either AC or DC), a 110 or 240 volt AC signal, or a 5 volt DC signal. Of course, a discrete device may be designed to operate in accordance with any electrical specification required by a particular control environment. A discrete input field device is simply a switch which either makes or breaks the connection to the control room, while a discrete output field device will take an action based on the presence or absence of a signal from the control room.

[0007] Historically, most traditional field devices have had either a single input or a single output that was directly related to the primary function performed by the field device. For example, the only function implemented by a traditional analog resistive temperature sensor is to transmit a temperature by modulating the current flowing through the two-wire twisted pair, while the only function implemented by a traditional analog valve positioner is to position a valve between an open and closed position, inclusive, based on the magnitude of the current flowing through the two-wire twisted pair.

[0008] More recently, hybrid systems that superimpose digital data on the current loop have been used in distributed control systems. One hybrid system is known in the control art as the Highway Addressable Remote Transducer (HART) and is similar to the Bell 202 modem specification. The HART system uses the magnitude of the current in the current loop to sense a process variable (as in the traditional system), but also superimposes a digital carrier signal upon the current loop signal. The carrier signal is relatively slow, and can provide updates of a secondary process variable at a rate of approximately 2-3 updates per second. Generally, the digital carrier signal is used to send secondary and diagnostic information and is not used to realize the primary control function of the field device. Examples of information provided over the carrier signal include secondary process variables, diagnostic information (including sensor diagnostics, device diagnostics, wiring diagnostics, and process diagnostics), operating temperatures, temperature of the sensor, calibration information, device ID numbers, materials of construction, configuration or programming information, etc. Accordingly, a single hybrid field device may have a variety of input and output variables and may implement a variety of functions.

[0009] HART is an industry standard nonproprietary

system. However, it is relatively slow. Other companies in the industry have developed proprietary digital transmission schemes which are faster, but these schemes are generally not used by or available to competitors.

[0010] More recently, a newer control protocol has been defined by the Instrument Society of America (ISA). The new protocol is generally referred to as Fieldbus, and is specifically referred to as SP50, which is an acronym for Standards and Practice Subcommittee 50. The Fieldbus protocol defines two subprotocols. An H1 Fieldbus network transmits data at a rate up to 31.25 kilobits per second and provides power to field devices coupled to the network. An H2 Fieldbus network transmits data at a rate up to 2.5 megabits per second, does not provide power to field devices connected to the network, and is provided with redundant transmission media. Fieldbus is a nonproprietary open standard and is attracting attention in the industry.

[0011] As additional protocols and architecture gain popularity in the industry, the industry will face greater and greater challenges melding these technologies together into a single distributed control system. For example, newer devices will be coupled to an existing distributed control system. In these situations, the signals coming from the control room may expect traditional analog or hybrid technologies, but the field devices may be coupled to an H1 or H2 Fieldbus network. Conversely, the control room of the industrial plant may be renovated, with the inputs and outputs to the control room comprising a modern H1 or H2 field bus, and the individual signals running to some older analog and hybrid field devices, and newer Fieldbus based field devices.

[0012] In addition to the challenge of integrating various technologies into a single distributed control system, newer field devices will have maintenance modes and enhanced functions that are not accessible via an older control system. In addition, even when all components of a distributed control system adhere to the same standard (such as the Fieldbus standard), one manufacturer's control room equipment may not be able to access the secondary functions or secondary information provided by another manufacturer's field devices.

[0013] The present invention provides a system as defined in claim 1 for providing non-redundant secondary access to field devices in a distributed control system having a control room for providing primary access to the field devices, thereby enabling secondary access of all information and functions available in field devices.

[0014] The present invention also provides a system as defined in claim 14 for providing redundant wireless access to field devices in a distributed control system having a control room that provides hard-wired access to the field devices, thereby allowing redundant access to the field devices in the event of a failure of the hard-wired media.

[0015] Each field device is provided with a wireless port and can be accessed by a wireless handheld unit

or a wireless terminal. In one embodiment, the wireless port is powered by the control network to which the field device is connected.

[0016] In a second embodiment of the invention, a field module having a wireless port is connected to an existing control network. The field module provides access from a wireless handheld unit or a wireless terminal (which may be in the control room) to all field devices connected to the control network. In one configuration of this embodiment, the field module is powered by the control network to which it is connected.

[0017] In a third embodiment of the invention, the distributed control system is provided with a bridge that connects a distribution network in the distributed control system to one or more control networks, wherein the control networks are coupled to field devices. The bridge also includes a wireless port that provides access from a wireless handheld unit or a wireless terminal (which may be in the control room) to all field devices connected to the control networks.

[0018] In a fourth embodiment of the present invention, a bridge/converter is connected to two-wire twisted pair analog wires coming from an older control room designed to control analog field devices, and couples the older control room to newer network-based field devices. In one configuration of this embodiment, the bridge/converter includes a hard-wired port that is coupled to a terminal. The terminal, which may be placed in the control room, provides the operators of the control system with access to all functions and secondary information of the newer network-based field devices that are not accessible by the older analog components of the control room. In another configuration of this embodiment (which may compliment the first configuration), the bridge/converter is provided with a wireless port that allows the network-based devices to be accessed by a wireless terminal or a wireless handheld unit.

[0019] Figure 1 is a diagram of a prior art distributed control system.

[0020] Figure 2A is a diagram of an industrial plant having two distributed control systems and shows three embodiments of the present invention.

[0021] Figure 2B is a diagram of industrial plant having two distributed control systems and shows three embodiments of the present invention.

[0022] Figure 3 is a diagram of an industrial plant having an older analog distributed control system that has been retrofitted with newer network-based field devices and shows an embodiment of the present invention.

[0023] Figure 1 is a block diagram of a prior art distributed control system (DCS) 10. DCS 10 is comprised of control room 12, controller 14, discrete/analog I/O unit 16, H2-to-H1 bridge 18, and a variety of field devices represented by solenoid 24, switches 26 and 54, valve positioners 28, 46, and 52, transmitters 30, 34, and 44, process analyzers 36 and 50. These devices represent any type of field device known in the control art. Also shown in Figure 1 are handheld units 38 and 39, which

are capable of accessing information in a hybrid or Fieldbus-based field device via a physical wire connection, and a local operator/user station 40, which is capable of issuing and receiving control room-type commands to and from the field device to which it is connected via a physical wire connection.

[0024] Control room 12 includes computers, user I/O, various forms of data storage devices, and other computing devices known in the art. Control room 12 is coupled to controller 14 via bus 20, which is typically a proprietary digital communications network or an open digital communication network employing a proprietary protocol. Controller 14 receives various commands from control room 12 and provides data to control room 12.

[0025] As depicted in the prior art of Figure 1, DCS 10 is a hybrid system comprising two different types of field devices. Devices 24 - 36 are traditional analog, discrete, and hybrid analog/digital devices, wherein the primary control function of the device is realized by modulating a current. These field devices are coupled to discrete/analog I/O unit 16, with each device connected to an individual channel of unit 16 by a single pair of wires (and possibly two additional power wires in the case of a traditional four-wire field device). For example, solenoid 24 is coupled via two-wire twisted pair 42 to channel 43 of unit 16.

[0026] For a traditional analog or discrete field device, the only communication with the device occurs by modulating or switching the current running through the two-wire twisted pair, with the magnitude of the current representing a measured process variable (as in the case of the transmitter), or an action requested by controller 14 (as in the case of a valve positioner or solenoid). Traditional analog devices have a frequency response limited to approximately 10 Hz and receive power from the two-wire twisted pair.

[0027] Hybrid analog/digital devices operate in a manner similar to traditional analog devices, but also allow digital communication of secondary information by superimposing a digital carrier signal on the modulated current carried by the two-wire twisted pair. One such hybrid analog/digital system is known in the control art as Highway Addressable Remote Transducer (HART) and transmits data in a manner similar to a conventional computer modem adhering to the Bell 202 specification. Generally, the primary function of these devices is still realized by modulating the current through the loop, while other types of secondary information, such as diagnostic data, operating temperature, identification codes, error codes, and secondary variables, are transmitted digitally. In such a system, digital communication is relatively slow and is limited to approximately 300 baud. When a maintenance person desires to test an analog device, the maintenance person must make a physical connection to the device itself, such as local operator/user station 40 connected to transmitter 30, or to the two-wire twisted pair leading to the device, such as handheld unit 38 connected to the two-wire twisted

pair leading to valve positioner 28.

[0028] In contrast, devices 44 - 54 are modern network-based digital field devices, wherein all information is digitally transmitted to and from each device. While many control system manufacturers have developed proprietary digital systems, the Standards and Practices Subcommittee 50 of the Instrument Society of America has developed and specified an architecture known in the art as Fieldbus. The Fieldbus specification includes two types of networks, a lower speed network referred to as H1 and a higher speed network referred to as H2. Both networks can support multiple connections to a single network bus, in contrast to traditional analog connections, which only support one device per two-wire twisted pair. While the present embodiments are described herein with reference to a Fieldbus network-based control system, in other embodiments the present invention may be employed in any distributed control system having network-based field devices.

[0029] A Fieldbus H2 network can transmit data at a rate up to 2.5 megabits per second. In addition, an H2 network is redundant, with two sets of physical wire media comprising the network. Should the primary wire media fail, the secondary wire media is automatically used by the DCS. Because of the high capacity and redundancy of H2 Fieldbus networks, H2 Fieldbus networks are beginning to be used as a distribution network that connect the controller to various distribution units in the DCS. However, traditional distribution networks are proprietary networks using either parallel or serial communication.

[0030] In Figure 1, H2 distribution network 22 couples controller 14 to H2-to-H1 bridge 18, and proprietary bus 21 couples controller 14 to discrete/analog I/O unit 16. In other configurations known in the art, unit 16 and bridge 18 may be coupled to a common distribution network. As previously discussed, discrete/analog I/O unit 16 includes discrete channels, with each channel coupled to a single device.

[0031] H2-to-H1 bridge links the data carried by proprietary distribution network 22 to H1 Fieldbus control networks 45 and 47. H1 Fieldbus control network 45 is coupled to transmitters 44, valve positioner 46, and relay 48, and H1 Fieldbus 47 is coupled to process analyzer 50, valve positioner 52, and solenoid 54. While an H1 Fieldbus network is not redundant, and has a lower data transmission rate of approximately 31.25 kilobits per second, it is capable of providing power to the devices to which it is coupled, while an H2 Fieldbus network does not. For the above reasons, the H1 Fieldbus network is ideal for providing final connections to individual field devices, while the H2 Fieldbus network is ideal for distributing control signals throughout the physical plant in which the DCS is installed.

[0032] More recently, field devices have been provided in the prior art with microprocessors and additional functionality. Such "smart" field devices are capable of monitoring a plurality of process variables, performing

a variety of control functions, performing comprehensive diagnostics, and providing a wide array of various types of status information. The Fieldbus specification specifies a variety of functions that may be supported by various Fieldbus field devices. In addition, many manufacturers have provided secondary functions beyond those specified in the Fieldbus specification. While Fieldbus field devices manufactured by different manufacturers are compatible to the extent that only Fieldbus specified functions are accessed, they are not compatible with respect to the secondary functions. For example, a Fieldbus controller manufactured by company A will generally not be able to access the secondary functions provided by a Fieldbus valve positioner manufactured by company B. Therefore, an industrial plant using a variety of Fieldbus components provided by different manufacturers will not be able to derive the benefit of all the functions provided by the various components.

[0033] The problem is worse in older distributed control systems that were designed to use traditional analog/discrete and hybrid devices. Often a company will wish to preserve an investment in an existing installation, and will retrofit the installation with newer Fieldbus field devices. In such an installation, the control room will not even be able to access the standardized Fieldbus functions provided by the various devices. Accordingly, a need exists to access the secondary functions provided by various manufacturers, as well as standardized Fieldbus functions when a Fieldbus based device is connected to an older distributed control system.

[0034] Description is now given of embodiments of the present invention. Figure 2 is a diagram of an industrial plant having two distributed control systems. DCS 56 is comprised of control room 60, controller 62, bus 64, field device 66, valve positioner 68, transmitter 70, process analyzer 72, H1 Fieldbus control network 74, transmitter 76, valve positioner 78, solenoid 80, field module 82, and H1 Fieldbus control network 84. DCS 58 is comprised of control room 86, controller 88, bus 90, H2 Fieldbus distribution network 94, H2-to-H1 bridge 92, transmitters 96 and 100, valve positioner 98, and H1 Fieldbus control network 102. Buses 64 and 90 are normally proprietary digital communication networks, or open communication networks employing a proprietary protocol. Also shown in Figure 2 is terminal 104 and handheld control unit 110. Terminal 104 is coupled to wireless link module 106, which in turn is connected to wireless transceiver 108. Handheld control unit 110 includes wireless transceiver 112.

[0035] Two embodiments of the present invention are illustrated in DCS 56. The first embodiment is illustrated by those field devices coupled to H1 Fieldbus control network 74. Each field device on control network 74 includes a wireless transceiver. Field device 66 represents any generic field device coupled to control network 74 and includes wireless transceiver 114. Valve positioner 68 includes wireless transceiver 116, transmitter 70 includes wireless transceiver 118, and process ana-

lyzer 72 includes wireless transceiver 120. Each wireless transceiver implements a wireless Fieldbus connection with terminal 104 and handheld unit 110, thereby allowing access to secondary functions of each field device not accessible by control room 60, as well as providing a maintenance person with convenient access to each field device without having to communicate with the control room and independent of the distributed control system.

[0036] The wireless Fieldbus connections described herein are implemented by secondary wireless network ports that are used in addition to primary network ports that are hardwired to a control room. Accordingly, a network-based field device may alternately be accessed via either the hardwired connection to the control room or the wireless Fieldbus connection. In contrast, many prior art network-based field devices are provided with a redundant hardwired network connection that is used as a backup if the first connection fails. However, the field device is generally not alternately accessed by either the first or redundant connections, except for testing the redundant connection. In addition, typically the redundant connection is also routed to the control room.

[0037] Another feature of the embodiment is that the wireless Fieldbus port attached to each field device is powered by the hardwired H1 Fieldbus port attached to each device. Therefore, a customer having Fieldbus control equipment from one manufacturer can connect field devices having a wireless Fieldbus port (in accordance with the present invention) to an existing H1 Fieldbus control network, and can access all the functions of the added field devices using a handheld unit having a wireless Fieldbus link, or a terminal having a wireless Fieldbus link. Since the wireless Fieldbus link of the field devices is powered by the existing H1 Fieldbus control network, no additional wiring is required.

[0038] The wireless links disclosed herein represent any wireless communication method known in the art, including, but not limited to, radio, infrared, visible light, and ultrasonic forms of wireless communication.

[0039] A second embodiment of the present invention is illustrated by the devices connected to H1 Fieldbus control network 84. Transmitter 76, valve positioner 78, and solenoid 80 are each coupled to control network 84. Also coupled to control network 84 is field module 82, which includes a wireless transceiver 122 powered by H1 Fieldbus control network 84. Field module 82, in essence, forms a wireless bridge between control network 84 and handheld unit 110 or terminal 104, and allows unit 110 or terminal 104 to access each device coupled to H1 Fieldbus control network 84. Accordingly, field module 82 is ideally suited for use in an existing environment having a variety of H1 Fieldbus devices from different manufacturers. Handheld unit 110 and terminal 104 can easily be programmed to access the functions of each device on the control network to which field module 82 is connected.

[0040] A third embodiment of the present invention is

illustrated by DCS 58. In DCS 58, controller 88 is coupled to H2-to-H1 bridge by H2 Fieldbus distribution network 94. H2-to-H1 bridge links H2 Fieldbus distribution network 94 to H1 Fieldbus control network 102. H2-to-H1 bridge also includes a second Fieldbus port connected to wireless transceiver 124, and communicates with a remote device such as handheld unit 110 or terminal 104. Accordingly, the remote wireless field device can access all field devices serviced by the H2-to-H1 bridge, such as transmitters 96 and 100 and valve positioner 98. In other configurations, it is common for an H2-to-H1 bridge to service a plurality of H1 Fieldbus control networks, in which case all field devices connected to all control networks serviced by the H2-to-H1 bridge can be accessed remotely.

[0041] Many industrial plants have a plurality of distributed control systems. By using wireless Fieldbus networks, a maintenance person can walk from DCS to DCS with a single handheld control unit and access field devices coupled to each DCS. Since the handheld control unit can be programmed to access each field device, the maintenance person can access all the functions of devices supplied by different manufacturers.

[0042] The present invention also provides a system for providing redundant wireless access to field devices in a distributed control system, thereby allowing access to field devices in the event of a failure of the hard-wired media that connects the field devices to a control room. The redundant wireless access can be used several ways. First, it can be used to allow continued operation of a distributed control system in the event of failure of or maintenance on the hard-wired media. However, even if continued operation is not desired, redundant wireless access may still be valuable for monitoring process variables and performing control actions, such as those required to shut down a process. For example, consider a distributed control system that is subjected to some sort of mishap, such as an explosion. The explosion, may vary well render the hard-wired media connecting field devices to the control room inoperable. Using the redundant wireless access provided by the present invention, a control room operator will still be able to access field device to perform an orderly shutdown of the distributed control system. The operator may observe critical temperatures and pressures, and adjust or close valves and other devices to complete the shut down. By having redundant wireless access to the field devices, the operator may be able to effect a shut-down in such a way as to minimize losses.

[0043] Figure 2B is a diagram of an industrial plant having two distributed control systems similar to Figure 2A and wherein the same components have the same reference numerals. DCS 56 in Figure 2B is comprised of control room 60 (which now includes terminal 104 coupled to wireless link module 106, which in turn is connected to wireless transceiver 108), controller 62, bus 64, field device 66, etc., as described for Figure 2A. DCS 58 is comprised of control room 86 (which now includes

terminal 103 coupled to wireless link module 107, which in turn is connected to wireless transceiver 109), controller 88, bus 90, etc., as described for Figure 2A.

[0044] Two embodiments of the invention of Figure 2B are illustrated in DCS 56. The first embodiment is illustrated by those field devices coupled to H1 Fieldbus control network 74. Each field device on control network 74 includes a wireless transceiver. Each wireless transceiver implements a redundant wireless Fieldbus connection with terminal 104, thereby allowing redundant wireless access to each field device from control room 60.

[0045] A second embodiment of the invention of Figure 2B is illustrated by the devices connected to H1 Fieldbus control network 84. Transmitter 76, valve positioner 78, and solenoid 80 are each coupled to control network 84. Also coupled to control network 84 is field module 82, which includes a wireless transceiver 122 powered by H1 Fieldbus control network 84. Field module 82, in essence, forms a wireless bridge between control network 84 and terminal 104 in control room 56, and allows terminal 104 to access each device coupled to H1 Fieldbus control network 84. Accordingly, field module 82 is ideally suited for providing redundant wireless access in an existing environment having a variety of H1 Fieldbus devices from different manufacturers.

[0046] A third embodiment of the invention of Figure 2B is illustrated by DCS 58. In DCS 58, controller 88 is coupled to H2-to-H1 bridge by H2 Fieldbus distribution network 94. H2-to-H1 bridge links H2 Fieldbus distribution network 94 to H1 Fieldbus control network 102. H2-to-H1 bridge also includes a second Fieldbus port connected to wireless transceiver 124, and communicates with a remote device such as terminal 103. Accordingly, terminal 103 in control room 86 can access all field devices serviced by the H2-to-H1 bridge, such as transmitters 96 and 100 and valve positioner 98.

[0047] Figure 3 shows an embodiment of the present invention adapted for use in older distributed control systems that have been retrofitted with newer Fieldbus field devices. DCS 126 includes control room 128, controller 130, bus 132, discrete/analog I/O unit 134, bridge/converter 136, bus 137, H1 Fieldbus control networks 138 and 140, solenoids 142 and 152, transmitters 144 and 148, valve positioner 146 and 150, handheld unit 154, and terminal 156.

[0048] DCS 126 represents an older distributed control system designed for use with traditional discrete analog/discrete and hybrid field devices. With the exception of terminal 156, everything above dotted line 158 represents components that are part of an older existing installation. Everything below dotted line 158 (and terminal 156) represent newer Fieldbus components that have been added to the installation.

[0049] Bridge/converter 136 interfaces the older portion of DCS 126 (above dotted line 158) to the Fieldbus devices. Bridge/converter 136 includes a plurality of process I/O channels (such as channel 160) that are

coupled to corresponding process I/O channels of discrete/analog I/O unit 134 (such as channel 162) by two-wire twisted pairs (such as two-wire twisted pair 164). Bridge/converter 136 converts the analog, discrete, and/or hybrid information provided by discrete/analog I/O unit 134 into digital information that is transmitted to devices on H1 Fieldbus networks 138 and 140, and converts the digital information received from devices on networks 138 and 140 into analog, discrete, and/or hybrid information required by discrete/analog I/O unit 134.

[0050] From the viewpoint of control room 128, the Fieldbus field devices appear as traditional analog/discrete and hybrid field devices. Accordingly, control room 128 cannot access any of the secondary functions provided by the Fieldbus field devices. To access these functions, bridge/converter 136 is provided with an active hard-wired Fieldbus port 166 and wireless Fieldbus port 168.

[0051] Hard-wired Fieldbus port 166 is connected to Fieldbus network 170, which in turn is connected to terminal 156. In one embodiment, terminal 156 is located within control room 128, and provides operators within the control room with access to all the functions that are provided by the Fieldbus field devices, and are not accessible through existing control room components. Port 166 is not a redundant port, rather it is a secondary port that provides the control room with access to all the functions provided by the Fieldbus based devices. Accordingly, a control room operator may alternately access a Fieldbus based device via discrete/analog I/O unit 134, or terminal 156. In contrast, a redundant port is used as a backup if the first port fails. In the configuration shown in Figure 3, a redundant port would not be coupled to the control room.

[0052] Fieldbus port 168 is connected to wireless transceiver 172, thereby forming a wireless Fieldbus network similar to the wireless Fieldbus networks shown in Figure 2. Handheld unit 154 has wireless transceiver 174, and communicates with Fieldbus devices 142 - 152 via wireless transceiver 172, which is connected to wireless port 168 of bridge/converter 136. In addition to handheld unit 154, a terminal having a wireless link (such as terminal 104 and wireless link 106 in Figure 2) may be used to communicate with the field devices coupled to bridge/converter 136.

[0053] The present invention provides an apparatus for providing secondary access to field devices in a distributed control system having a control room for providing primary access to the field devices. In a modern distributed control system having Fieldbus devices coupled to a Fieldbus control room, the present invention provides a wireless link to a remote unit, such as a handheld device or a terminal having a wireless link, thereby allowing a maintenance person to access each Fieldbus device in the field via the remote unit. Since a Fieldbus control room from one manufacturer may not be able to access secondary functions of a Fieldbus device from

another manufacturer, the handheld unit can also provide a convenient way to access secondary functions provided by various manufacturers from a single, easily programmed handheld unit or remote terminal.

[0054] The present invention also provides an apparatus for providing wireless redundant access to field devices in a distributed control system having a control room that provides hard-wired access to the field devices. In a modern distributed control system having Fieldbus devices coupled to a Fieldbus control room, the present invention provides a redundant wireless to a terminal having a wireless link. The apparatus of the present invention allows access to field devices in the event of failure or other unavailability of the hard-wired media that couples the control room to field devices, which is the primary way of accessing the control devices.

[0055] In one embodiment, each Fieldbus-based device is provided with its own secondary wireless H1 or H2 Fieldbus port that is powered by the H1 Fieldbus control network. This embodiment provides maximum flexibility because no modification of the distributed control system is required, and is ideally suited for new devices that are to be added to an existing Fieldbus installation. As soon as the H1 Fieldbus device is connected to the existing H1 Fieldbus control network, the device can be accessed via the wireless handheld unit or the wireless terminal.

[0056] In another embodiment of the invention, a field module is connected to an existing Fieldbus control network. The field module has a wireless H1 or H2 Fieldbus port that is powered by the H1 Fieldbus control network, and provides access from the wireless handheld unit or the wireless terminal to all Fieldbus devices connected to the control network. This embodiment is ideally suited for distributed control systems that already have Fieldbus devices.

[0057] In yet another embodiment of the present invention, the distributed control system is provided with an H2-to-H1 bridge having one or more H1 control networks coupled to Fieldbus devices, a hard-wired H2 port coupled to a controller, and a wireless H2 or H1 Fieldbus port. The wireless Fieldbus port allows a wireless handheld unit or a wireless terminal to access all Fieldbus devices on all H1 control networks serviced by the H2-to-H1 bridge.

[0058] In a fourth embodiment of the present invention, a bridge/converter is connected to the two-wire twisted pair analog/discrete and hybrid wires coming from an older control room, and couples the older control room to newer Fieldbus devices. In this embodiment, the bridge/converter provides an H1 or H2 Fieldbus port to allow access to functions of the Fieldbus devices not accessible from the control room. In one configuration, a terminal is connected to the bridge/converter via a hard-wire Fieldbus network. The terminal, which may be placed in the control room, provides the operators of the control system with access to all functions of the Field-

bus-based devices. In another configuration (which may compliment the first configuration), the bridge/converter is provided with a wireless H1 or H2 Fieldbus port that allows the Fieldbus field devices to be accessed by a wireless terminal or a wireless handheld unit.

Claims

1. A distributed control system comprising:

a control room (60, 86) for providing primary control of the distributed control system;

a plurality of network based field devices (66 - 72), with each network based field device having a primary control network port;

a control network (74, 84, 94) coupled to each primary control network port of each network-based field device (66 - 72) of the plurality of network-based field devices;

a controller (62, 88) coupled to the control room (60, 86), for controlling and providing primary access to primary functions of the plurality of network based field devices (66 - 72);

network/controller connection means (92, 134, 136) for connecting the control network (74, 84, 94) to the controller (62, 88);

characterized by

secondary access means (114 - 120) for providing non-redundant wireless secondary access to secondary functions of the plurality of network-based field devices (66 - 72), and

a wireless terminal (104) or handheld unit (110) for implementing wireless access to secondary functions of each field device (66 - 72).

2. The distributed control system of Claim 1 wherein the secondary access means comprises:

a wireless transceiver (114) coupled to a non-redundant secondary port of each of the plurality of network-based field devices (66 - 72).

3. The distributed control system of Claim 2 wherein the wireless transceiver (114) is connected to receive power from the control network (74) via the primary control network port.

4. The distributed control system of claim 1 wherein the secondary access means comprises a field module (82) coupled to the control network (84), the

field module comprising a first network port coupled to the control network (84); a non-redundant secondary port; and a wireless transceiver (122) coupled to the non-redundant secondary port.

5. The distributed control system of Claim 4 wherein the field module (82) is connected to power from the control network (84) via the first network port.

6. The distributed control system of Claim 1 wherein the controller (88) is coupled to a distribution network (94), and the network/controller connection means comprises a bridge for transmitting information from the distribution network (94) to the control network (102), the bridge including a first port coupled to the distribution network (94); a second port coupled to the control network (102); a wireless transceiver (124); and a third non-redundant port coupled to the wireless transceiver (124).

7. The distributed control system of claim 1 wherein the network/controller connection means comprises:

a discrete/analog I/O unit (134) including a bus (137) coupled to the controller (130); and a plurality of discrete/analog I/O channels (162), and a bridge/converter (136) including a plurality of discrete/analog I/O channels (160) coupled to the plurality of analog I/O channels (162) of the discrete analog I/O unit (134); a non-redundant network-based field device access port (168) for providing access to functions of the plurality of network-based field devices (142 - 152) not accessible via the controller (130); and a control network port coupled to the control network (138, 140).

8. The distributed control system of Claim 7 further comprising a terminal (156); and a hard-wired connection (170) between the terminal and the non-redundant network-based field device access port (166) of the bridge/converter (136).

9. The distributed control system of Claim 7, further comprising a wireless transceiver (172) coupled to the non-redundant network-based field device access port (168) of the bridge/converter; and a remote access device (14) having a wireless transceiver (174), for remotely accessing the plurality of network-based field devices (142 - 152).

10. The distributed control system of any one of the Claims 1 to 9, wherein each network-based field device comprises control means (66 - 72) for implementing a control function; said primary control network port for providing primary control access to the network-based field device (66 - 72); and a non-re-

dundant secondary port for providing non-redundant secondary access to the network-based field device.

11. The distributed control system of Claim 10 wherein the network-based field device implements a set of functions, with the subset of secondary functions accessible via the non-redundant secondary port and not accessible via the primary control network port.

12. The distributed control system of Claim 4 or 5 wherein the field module (82) facilitates access to the subset of secondary functions implemented by field devices connected to a control network, and the subset of secondary functions cannot be accessed by a controller (62) coupled to the control network (84).

13. The distributed control system of Claim 6 wherein the bridge (92) facilitates access to a subset of secondary functions implemented by field devices connected to a control network (102), and the subset of secondary functions cannot be accessed by a controller (88) coupled to the distribution network (90).

14. A distributed control system comprising a control room (60, 86) for providing primary control of the distributed control system via hard-wired media;

a plurality of network-based field devices (66 - 72), with each network based field device having a primary control network port;

a control network (74, 84, 94) coupled to each primary control network port of each network-based field device of the plurality of network-based field devices (66 - 72);

a controller (62, 88) coupled to the control room (60, 86), for controlling and providing primary access to primary functions of the plurality of network-based field devices (66 - 72);

network/controller connection means (92, 134, 136) for connecting the control network to the controller (60, 86);

characterized by

secondary access means (114 - 120) for providing redundant wireless access to the same functions of the plurality of network-based field devices (66 - 72); and

a wireless terminal (103, 104) coupled to a wireless link (106, 107) in the control room (60, 86).

15. The distributed control system of Claim 14 wherein the secondary access means further comprises a first wireless transceiver (124, 172) configured to provide non-wireless access to the plurality of network-based devices (96 - 100, 142 - 152); and a remote access device (154) having a second wireless transceiver (174), for remotely accessing the plurality of network-based field devices via the first wireless transceiver (124, 172).

16. The distributed control system of Claim 14 or 15 wherein the secondary access means comprises a remote terminal (156) configured to provide non-wireless access to the plurality of networked based devices.

Patentansprüche

1. Verteiltes Steuerungssystem, mit:

einem Kontrollraum (60, 86) zum Vorsehen einer primären Steuerung des verteilten Steuerungssystems;

einer Vielzahl von netzwerkgestützten Feldgeräten (66-72), wobei jedes netzwerkgestützte Feldgerät einen primären Steuernetzwerk-Anschluß besitzt;

einem Steuernetzwerk (74, 84, 94), welches an jeden primären Steuernetzwerk-Anschluß von jedem netzwerkgestützten Feldgerät (66-72) der Vielzahl der netzwerkgestützten Feldgeräte gekoppelt ist;

einem Controller (62, 88), der an den Kontrollraum (60, 86) gekoppelt ist, um einen primären Zugriff auf primäre Funktionen der Vielzahl der netzwerkgestützten Feldgeräte (66-72) bereitzustellen und zu steuern;

einer Netzwerk/Controller-Verbindungseinrichtung (92, 134, 136) zum Verbinden des Steuernetzwerks (74, 84, 94) mit dem Controller (62, 88);

gekennzeichnet durch

eine sekundäre Zugriffseinrichtung (114-120), um einen nicht redundanten drahtlosen sekundären Zugriff auf sekundäre Funktionen der Vielzahl der netzwerkgestützten Feldgeräte (66-72) zu erzeugen, und

ein drahtloses Terminal (104) oder eine tragbare Einheit (110), um einen drahtlosen Zugriff auf sekundäre Funktionen von jedem Feldgerät

(66-72) auszuführen.

2. Verteiltes Steuerungssystem nach Anspruch 1, bei dem die sekundäre Zugriffseinrichtung folgendes umfaßt:

einen drahtlosen Sender/Empfänger (114), der an einen nicht-redundanten sekundären Anschluß von jeder der Vielzahl der netzwerkgestützten Feldgeräte (66-72) gekoppelt ist.

3. Verteiltes Steuerungssystem nach Anspruch 2, bei dem der drahtlose Sender/Empfänger (114) so angeschlossen ist, daß er Energie von dem Steuernetzwerk (74) über den primären Steuernetzwerk-Anschluß empfängt.

4. Verteiltes Steuerungssystem nach Anspruch 1, bei dem die sekundäre Zugriffseinrichtung ein Feldmodul (82) umfaßt, das an das Steuernetzwerk (84) gekoppelt ist, wobei das Feldmodul einen ersten Netzwerk-Anschluß umfaßt, der an das Steuernetzwerk (84) gekoppelt ist; einen nicht redundanten sekundären Anschluß; und einen drahtlosen Sender/Empfänger (122), der an den nicht-redundanten sekundären Anschluß gekoppelt ist.

5. Verteiltes Steuerungssystem nach Anspruch 4, bei dem das Feldmodul (82) mit der Stromversorgung von dem Steuernetzwerk (84) über den ersten Netzwerk-Anschluß verbunden ist.

6. Verteiltes Steuerungssystem nach Anspruch 1, bei dem der Kontroller (88) an ein Verteilungsnetzwerk (94) gekoppelt ist, und bei dem die Netzwerk/Kontroller-Verbindeinrichtung eine Brücke umfaßt, um Informationen von dem Verteilungsnetzwerk (94) zu dem Steuernetzwerk (102) zu übermitteln, wobei die Brücke einen ersten Anschluß enthält, der an das Verteilungsnetzwerk (94) gekoppelt ist; einen zweiten Anschluß, der an das Steuernetzwerk (102) gekoppelt ist; einen drahtlosen Sender/Empfänger (124); und einen dritten nicht-redundanten Anschluß, der an den drahtlosen Sender/Empfänger (124) gekoppelt ist.

7. Verteiltes Steuerungssystem nach Anspruch 1, bei dem die Netzwerk/Kontroller-Verbindeinrichtung folgendes umfaßt:

eine diskrete/analoge-I/O-Einheit (134), die einen Bus (137) enthält, der an den Kontroller (130) gekoppelt ist; und eine Vielzahl von diskreten/analogen-I/O-Kanälen (162), und einen Brücken-Umsetzer (136), der eine Vielzahl von diskreten/analogen-I/O-Kanälen (160) enthält, die an die Vielzahl der analogen I/O-Kanäle (162) der diskreten/analogen-I/O-Einheit (134)

gekoppelt ist; einen nicht redundanten netzwerkgestützten Feldgeräte-Zugriffs-Anschluß (168), um einen Zugriff auf Funktionen der Vielzahl der netzwerkgestützten Feldgeräte (142-152) zu erzeugen, die nicht über den Kontroller (130) zugreifbar sind; und einen Steuernetzwerk-Anschluß, der an das Steuernetzwerk (138, 140) gekoppelt ist.

8. Verteiltes Steuerungssystem nach Anspruch 7, das ferner ein Terminal (156); und eine fest verdrahtete Verbindung (120) zwischen dem Terminal und dem nicht-redundanten netzwerkgestützten Feldgeräte-Zugriffs-Anschluß (166) des Brücken/Umsetzers (136) aufweist.

9. Verteiltes Steuerungssystem nach Anspruch 7, das ferner einen drahtlosen Sender/Empfänger (172), der an den nicht-redundanten netzwerkgestützten Feldgeräte-Zugriffs-Anschluß (168) des Brücken-Umsetzers gekoppelt ist; und einer Fern-Zugriffsvorrichtung (14) mit einem drahtlosen Sender/Empfänger (174), um von fern auf die Vielzahl der netzwerkgestützten Feldgeräte (142-152) zuzugreifen.

10. Verteiltes Steuerungssystem nach einem der Ansprüche 1 bis 9, wobei jedes netzwerkgestützte Feldgerät eine Steuereinrichtung (66-72) umfaßt, um eine Steuerfunktion auszuführen; der primäre Steuernetzwerk-Anschluß zum Erzeugen eines primären Steuerzugriffs auf die netzwerkgestützten Feldgeräte (66-72); und einen nicht-redundanten sekundären Anschluß umfaßt, um einen nicht-redundanten sekundären Zugriff auf die netzwerkgestützten Feldgeräte auszuführen.

11. Verteiltes Steuerungssystem nach Anspruch 10, bei dem das netzwerkgestützte Feldgerät einen Satz von Funktionen implementiert, wobei ein untergeordneter Satz der sekundären Funktionen über den nicht-redundanten sekundären Anschluß zugreifbar ist und über den primären Steuernetzwerk-Anschluß nicht zugreifbar ist.

12. Verteiltes Steuerungssystem nach Anspruch 4 oder 5, bei dem das Feldmodul (82) den Zugriff auf den untergeordneten Satz der sekundären Funktionen, die durch die Feldgeräte ausgeführt werden, welche an ein Steuernetzwerk angeschlossen sind, vereinfacht, und bei dem der untergeordnete Satz der sekundären Funktionen durch einen Kontroller (62), der an das Steuernetzwerk (84) gekoppelt ist, nicht zugreifbar ist.

13. Verteiltes Steuerungssystem nach Anspruch 6, bei dem die Brücke (92) den Zugriff auf einen untergeordneten Satz der sekundären Funktionen, die durch die Feldgeräte ausgeführt werden sind, wel-

che an das Steuernetzwerk (102) angeschlossen sind, vereinfacht, und bei dem der untergeordnete Satz der sekundären Funktionen durch einen Controller (88), der an das Verteilungs-Netzwerk (90) gekoppelt ist, nicht zugreifbar ist.

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14. Verteiltes Steuerungssystem, mit einem Kontrollraum (60, 86) zum Erzeugen einer primären Steuerung des verteilten Steuersystems über fest verdrahtete Medien;

einer Vielzahl von netzwerkgestützten Feldgeräten (66-72), wobei jedes netzwerkgestützte Feldgerät einen primären Steuernetzwerk-Anschluß besitzt;

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einem Steuernetzwerk (74, 84, 94), welches an jeden primären Steuernetzwerk-Anschluß von jedem netzwerkgestützten Feldgerät der Vielzahl der netzwerkgestützten Feldgeräte (66-72) gekoppelt ist;

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einem Controller (62, 88), der an den Kontrollraum (60, 86) gekoppelt ist, um einen primären Zugriff auf primäre Funktionen der Vielzahl der netzwerkgestützten Feldgeräte (66-72) zu steuern und vorzusehen;

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einer Netzwerk/Controller-Verbindungseinrichtung (92, 134, 136) zum Verbinden des Steuernetzwerks mit dem Controller (60, 86);

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gekennzeichnet durch

eine sekundäre Zugriffseinrichtung (114-120) zum Erzeugen eines redundanten drahtlosen Zugriffs auf die gleichen Funktionen der Vielzahl der netzwerkgestützten Feldgeräte (66-72); und

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ein drahtloses Terminal (103, 104), welches an ein drahtloses Verbindungsglied (106, 107) in dem Kontrollraum (60, 86) gekoppelt ist.

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15. Verteiltes Steuerungssystem nach Anspruch 14, bei dem die sekundäre Zugriffseinrichtung ferner einen ersten drahtlosen Sender/Empfänger (124, 172) umfaßt, der derart konfiguriert ist, um einen nicht drahtlosen Zugriff auf die Vielzahl der netzwerkgestützten Vorrichtungen (96-100, 142-152) zu erzeugen; und eine Fern-Zugriff-Vorrichtung (154), die einen zweiten drahtlosen Sender/Empfänger (174) umfaßt, um von fern auf die Vielzahl der netzwerkgestützten Feldgeräte über den ersten drahtlosen Sender/Empfänger (124, 172) zuzugreifen.

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16. Verteiltes Steuerungssystem nach Anspruch 14

oder 15, bei dem die sekundäre Zugriffseinrichtung ein Fern-Terminal (156) aufweist, welches derart konfiguriert ist, um einen nicht drahtlosen Zugriff auf die Vielzahl der netzwerkgestützten Vorrichtungen vorzusehen.

Revendications

1. Système de commande distribuée comportant :

une salle de commande (60, 86) pour fournir une commande primaire du système de commande distribuée,

une pluralité de dispositifs installés sur un site basé sur un réseau (66-72), chaque dispositif installé sur le site basé sur un réseau ayant un port de réseau de commande primaire, un réseau de commande (74, 84, 94) relié à chaque port de réseau de commande primaire de chaque dispositif installé sur le site basé sur un réseau (66-72) de la pluralité de dispositifs installés sur un site basé sur un réseau, un dispositif de commande (62, 88) relié à la salle de commande (60, 86), pour commander et fournir un accès primaire à des fonctions primaires de la pluralité de dispositifs installés sur un site basé sur un réseau (66-72), des moyens de connexion de réseau/dispositif de commande (92, 134, 136) pour connecter le réseau de commande (74, 84, 94) au dispositif de commande (62, 88),

caractérisé par

des moyens d'accès secondaire (114-120) pour fournir un accès secondaire sans fil non-redondant à des fonctions secondaires de la pluralité de dispositifs installés sur un site basé sur un réseau (66-72), et un terminal sans fil (104) ou une unité portative (110) pour implémenter un accès sans fil à des fonctions secondaires de chaque dispositif installé sur le site (66-72) .

2. Système de commande distribuée selon la revendication 1, dans lequel les moyens d'accès secondaire comportent :

un émetteur-récepteur sans fil (114) relié à un port secondaire non-redondant de chaque dispositif de la pluralité de dispositifs installés sur un site basé sur un réseau (66-72).

3. Système de commande distribuée selon la revendication 2, dans lequel l'émetteur-récepteur sans fil (114) est connecté pour recevoir de la puissance depuis le réseau de commande (74) via le port de

réseau de commande primaire.

4. Système de commande distribuée selon la revendication 1, dans lequel les moyens d'accès secondaire comportent un module installé sur le site (82) relié au réseau de commande (84), le module installé sur le site comportant un premier port de réseau relié au réseau de commande (84), un port secondaire non-redondant, et un émetteur-récepteur sans fil (122) relié au port secondaire non-redondant.
5. Système de commande distribuée selon la revendication 4, dans lequel le module installé sur le site (82) reçoit de la puissance par le réseau de commande (84) via le premier port de réseau.
6. Système de commande distribuée selon la revendication 1, dans lequel le dispositif de commande (88) est relié à un réseau de distribution (94), et les moyens de connexion de réseau/dispositif de commande comportent un pont pour transmettre des informations du réseau de distribution (94) au réseau de commande (102), le pont comportant un premier port relié au réseau de distribution (94), un deuxième port relié au réseau de commande (102), un émetteur-récepteur sans fil (124), et un troisième port non-redondant relié à l'émetteur-récepteur sans fil (124).
7. Système de commande distribuée selon la revendication 1, dans lequel les moyens de connexion de réseau/dispositif de commande comportent :
 - une unité I/O discrète/analogique (134) comportant un bus (137) relié au dispositif de commande (130), et une pluralité de canaux I/O discrets/analogiques (162), et un pont/convertisseur (136) comportant une pluralité de canaux I/O discrets/analogiques (160) reliés à la pluralité de canaux I/O analogiques (162) de l'unité I/O discrète/analogique (134), un port d'accès non-redondant (168) aux dispositifs installés sur le site basé sur un réseau pour fournir un accès à des fonctions de la pluralité de dispositifs installés sur le site basé sur un réseau (142-152) qui ne sont pas accessibles via le dispositif de commande (130), et un port de réseau de commande relié au réseau de commande (138, 140).
8. Système de commande distribuée selon la revendication 7, comportant de plus un terminal (156), et une connexion câblée (170) entre le terminal et le port d'accès non-redondant (166) aux dispositifs installés sur le site basé sur un réseau, du pont/convertisseur (136).

9. Système de commande distribuée selon la revendication 7, comportant de plus un émetteur-récepteur sans fil (172) relié au port d'accès non-redondant (168) aux dispositifs installés sur le site basé sur un réseau, du pont/convertisseur, et un dispositif d'accès à distance (14) ayant un émetteur-récepteur sans fil (174), pour avoir accès à distance à la pluralité de dispositifs installés sur le site basé sur un réseau (142-152).
10. Système de commande distribuée selon l'une quelconque des revendications 1 à 9, dans lequel chaque dispositif installé sur le site basé sur un réseau comporte des moyens de commande (66-72) pour implémenter une fonction de commande, ledit port de réseau de commande primaire destiné à fournir un accès de commande primaire au dispositif installé sur le site basé sur un réseau (66-72), et un port secondaire non-redondant pour fournir un accès secondaire non-redondant au dispositif installé sur le site basé sur un réseau.
11. Système de commande distribuée selon la revendication 10, dans lequel le dispositif installé sur le site basé sur un réseau implémente un ensemble de fonctions, le sous-ensemble de fonctions secondaires étant accessible via le port secondaire non-redondant et inaccessible via le port de réseau de commande primaire.
12. Système de commande distribuée selon la revendication 4 ou 5, dans lequel le module installé sur le site (82) facilite l'accès au sous-ensemble de fonctions secondaires implémentées par les dispositifs installés sur le site connectés au réseau de commande, et un dispositif de commande (62) relié au réseau de commande (84) ne peut pas avoir accès au sous-ensemble de fonctions secondaires.
13. Système de commande distribuée selon la revendication 6, dans lequel le pont (92) facilite l'accès à un sous-ensemble de fonctions secondaires implémentées par des dispositifs installés sur le site reliés à un réseau de commande (102), et un dispositif de commande (88) relié au réseau de distribution (90) ne peut pas avoir accès au sous-ensemble de fonctions secondaires.
14. Système de commande distribuée comportant une salle de commande (60, 86) pour fournir une commande primaire du système de commande distribuée via des supports câblés,
 - une pluralité de dispositifs installés sur un site basé sur un réseau (66-72), chaque dispositif installé sur le site basé sur un réseau ayant un port de réseau de commande primaire, un réseau de commande (74, 84, 94) relié à

chaque port de réseau de commande primaire
de chaque dispositif installé sur le site basé sur
un réseau de la pluralité de dispositifs installés
sur le site basés sur un réseau (66-72),
un dispositif de commande (62, 88) relié à la 5
salle de commande (60, 86), pour commander
et fournir un accès primaire à des fonctions pri-
maires de la pluralité de dispositifs installés sur
le site basé sur un réseau (66-72),
des moyens de connexion de réseau/dispositif 10
de commande (92, 134, 136) pour connecter le
réseau de commande au dispositif de comman-
de (60, 86),

caractérisé par 15

des moyens d'accès secondaire (114-120)
pour fournir un accès sans fil redondant aux
mêmes fonctions de la pluralité de dispositifs
installés sur le site basé sur un réseau (66-72), 20
et
un terminal sans fil (103, 104) relié à une liaison
sans fil (106, 107) dans la salle de commande
(60, 86).

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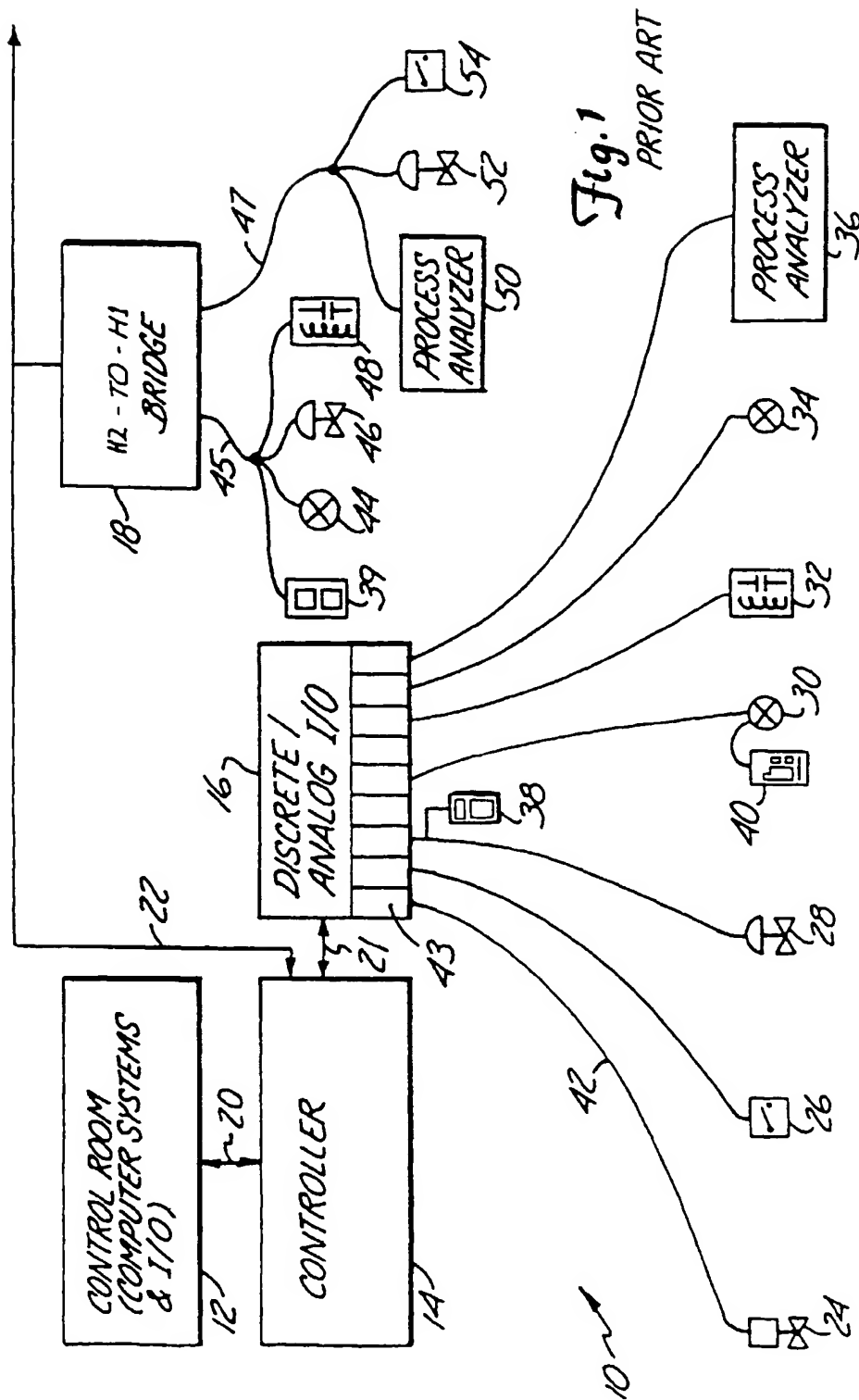
15. Système de commande distribuée selon la reven-
dication 14, dans lequel les moyens d'accès secon-
daire comportent de plus un premier émetteur-ré-
cepteur sans fil (124, 172) configuré pour fournir un
accès qui n'est pas sans fil à la pluralité de dispo- 30
sitifs basés sur un réseau (96-100, 142-152), et un
dispositif d'accès à distance (154) ayant un second
émetteur-récepteur sans fil (174), pour avoir accès
à distance à la pluralité de dispositifs installés sur
le site basé sur un réseau via le premier émetteur- 35
récepteur sans fil (124, 172).

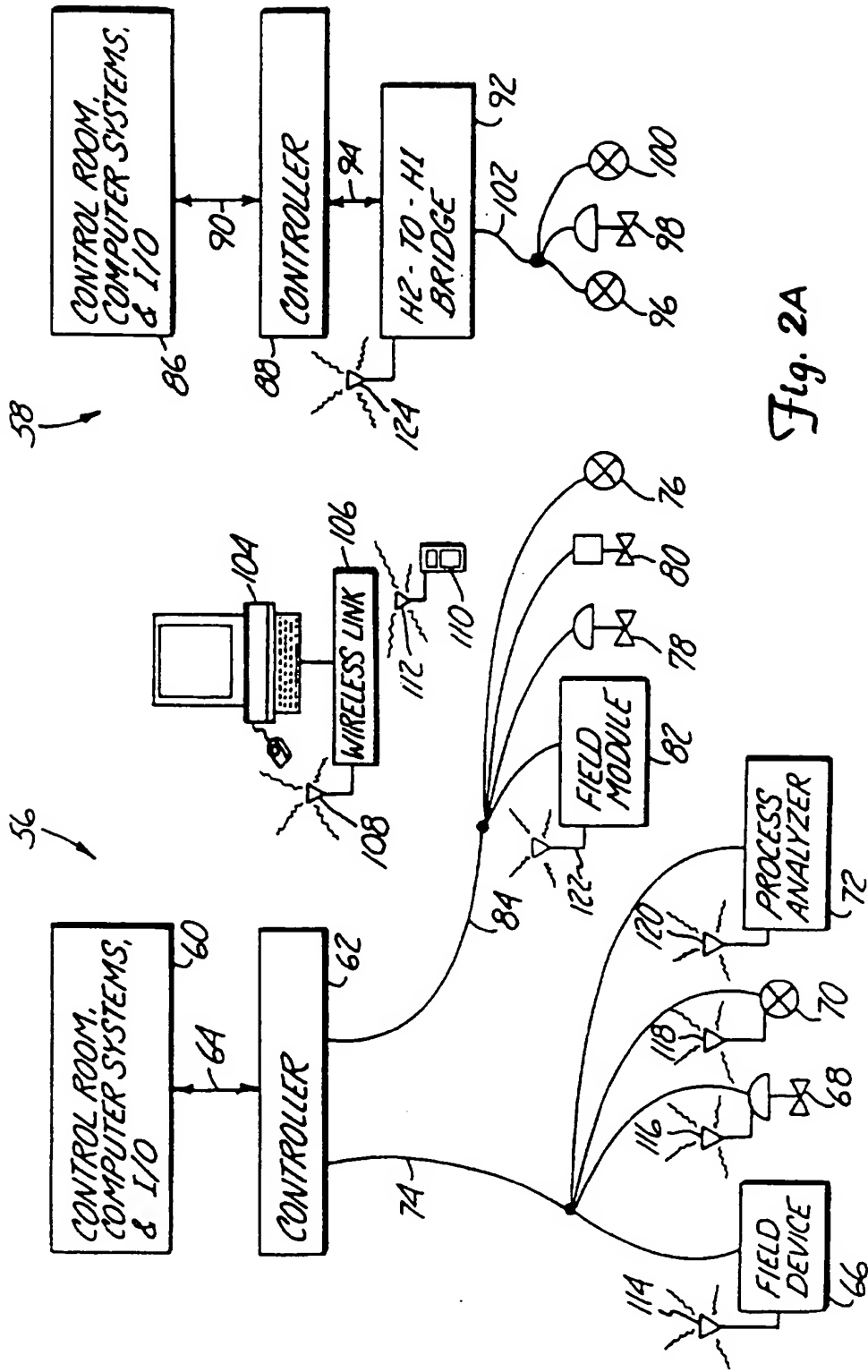
16. Système de commande distribuée selon la reven-
dication 14 ou 15, dans lequel les moyens d'accès
secondaire comportent un terminal à distance (156) 40
configuré pour fournir un accès qui n'est pas sans
fil à la pluralité de dispositifs agencés en réseau.

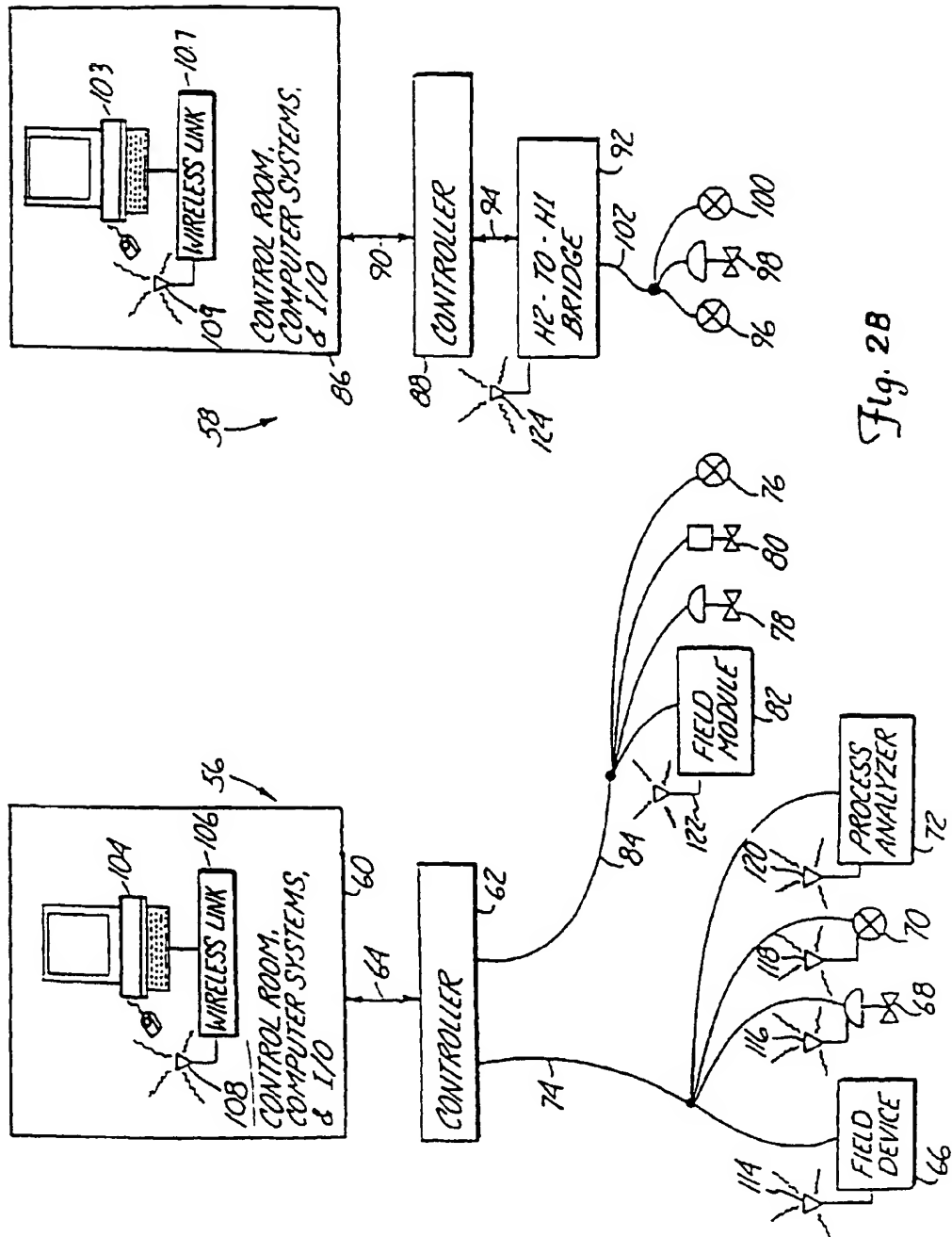
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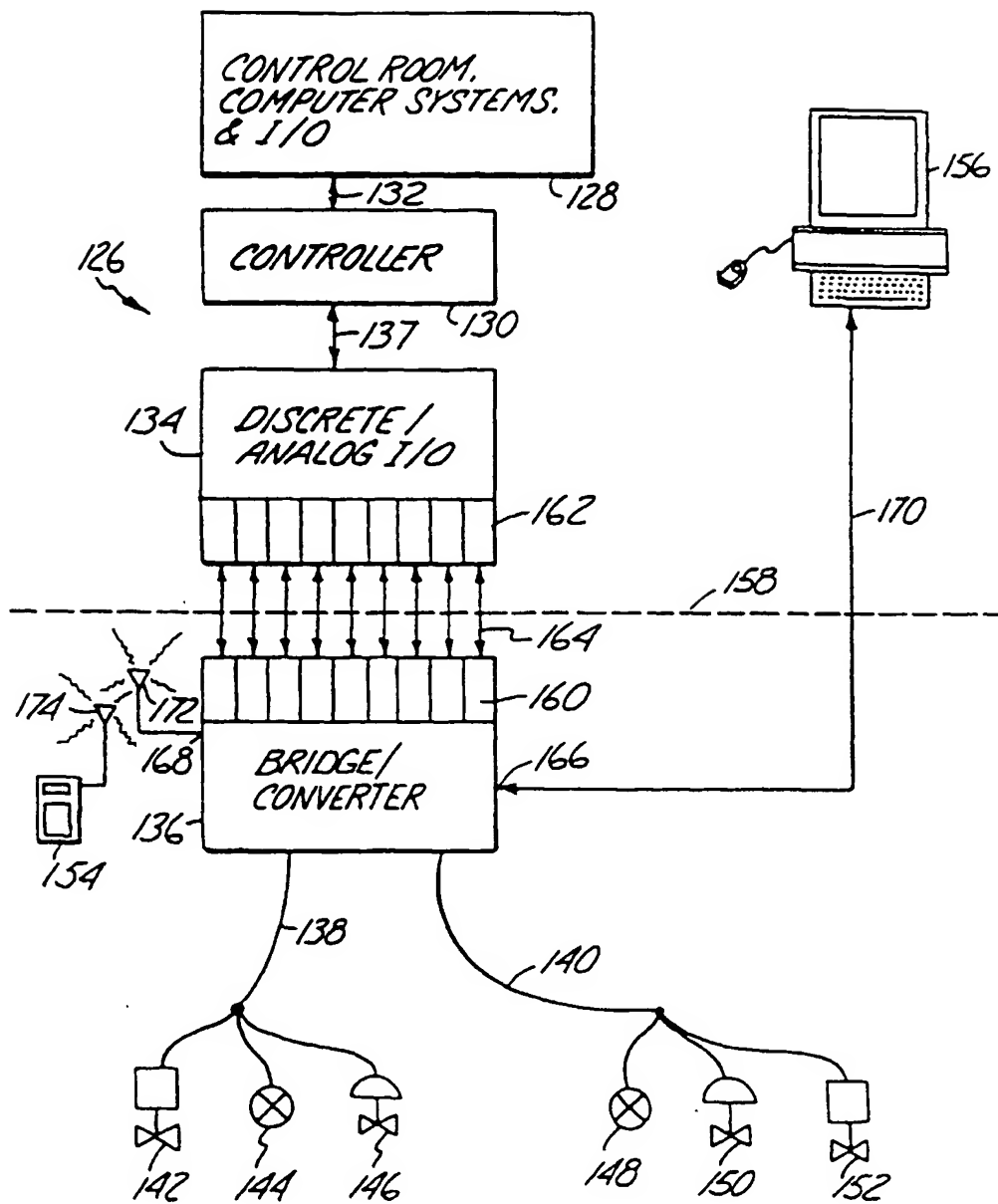


Fig. 3

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